

APPENDIX H

MAIN UNIT MISCELLANEOUS DATA AND OPERATIONS PROGRAM

Ion-Exchange System

Description of Control Software

Operations Program for Analog MACSYM Computer

List of Device Connection to Analog Operation Computer

Output for Worksheet Program to Determine IX Operation Schedule

Volume Information on IX Columns

Manufacturers Resin Reports

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ION EXCHANGE CONTROL SOFTWARE

The ion exchange (IX) installation at the Los Banos demonstration Desalting Facility performs a vital function in plant operations. It removes calcium ion from the incoming process water. These ions can scale the reverse osmosis (RO) membranes in the next stage of plant operations. The IX operation cycle is timed and controlled with an Analog Devices Macsym2 process control computer. The IX units at the desalting facility have a daily capacity of roughly 330,000 gallons per day. They are located outside the facility's RO building.

In terms of IX control software requirements, the IX units must be put through a complex sequence of valve and flowrate "events". A typical event sequence is illustrated in Figure 1.1. Each event can vary in timing, valves, and pumps used. Since the two units share some equipment, equipment conflicts must be detected and avoided. IX cycle status, IX cycle halts, IX unit flushes, brine tank transfers and an emergency halt of all processes must also be available. Lastly, the IX control software must log the start and stop times of units and events to the site's Hewlett-Packard 1000 minicomputer, be simple to understand, and easy to operate.

The IX control software is written in a multi-tasking Macsym2 version of the Basic programming language. Multi-tasking is a term used to describe a computer program which can perform more than one job concurrently. In a multi-tasking program, the task scheduler of the computer's operating utility allocates CPU time to each active job (task). This allows for a single Macsym2 program have more than one section of its Basic code executing at the same time. In the IX control software, as many as five tasks may be executing at the same time, each task performing independently of the others. This allows the control software to closely control the complicated IX cycle.

In the IX control software, the menu serves as a master task, starting and stopping slave tasks which run parallel to it. The slave tasks execute in the background of menu operation. The slave tasks control Unit 2 and Unit 2 operation as well as most of the action choices from the main menu (MM). Typically, the main menu task inputs operation parameters for a requested action and starts a slave task to perform the action. The IX control program is illustrated in Figure 1.2.

In an effort to make the IX control program as flexible in operation as possible, it was necessary to provide options on how it functioned. These options do not change what the program does. Instead, the options change how the program accomplishes some parts of the IX cycle. The IX control program special option menu (SM) is a submenu accessed from the IX main menu as choice #7.

Before displaying the special options menu, the program asks the user to make an IX unit choice. All special options menu choices will change that option for only that unit. To change options for

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LOS BANOS FACILITY

both units, one must go back to the main menu and choose #7 again. In general, when the program asks the user for an option choice, pressing [return] will simply leave the last chosen option as the default choice.

ION EXCHANGE SYSTEM

FIGURE 1.1

LOS BANOS FACILITY

OPERATIONS SCHEDULE
REJECT BRINE REGENERATION
UPFLOW RINSE

DEFAULT DURATIONS AND FLOWS

16-Aug-86
WASTE BRINE TO RWPS
USED BRINE TO T2 OR T3
RINSE TO SL DRAIN

EVENT NUMBER	EVENT DESCRIPTION	DURATION (minutes)	COMPONENT OPERATION/VALVE OPEN		PROCESS FLOW Unit	from	to
			Unit 1	Unit 2			
1	Recyc.brine regen. 1	13	IP 5, A1 IV 15,12,7,9, 21	IP 5, A2 IV 115,112,107, 121	1 2	T4 T4	RWPS RWPS
2	Recyc.brine regen. 2	40	IP 5, A1 IV 15,7,4,23,*	IP 5, A2 IV 115,107,104, 123,*	1 2	T4 T4	T2 T3
3	Fresh brine regen.	9	IP 1, A1 IV 17,7,4,23, 39m, *	IP 1, A2 IV 18,107,104, 123,139m,*	1 2	T1 T1	T2 T3
4	Rinse A Upflow	6	IP 7, A1 IV 3,7,4,23,*	IP 9, A2 IV 103,107,104, 123,*	1 2	CW1 CW2	T2 T3
5	Rinse B Upflow	5	IP 7, A1 IV 3,7,4,23,*	IP 9, A2 IV 103,107,104	1 2	CW1 CW2	T2 T3
6	Rinse C Downflow	5	IP 7, A1 IV 1,7,4,21	IP 9, A2 IV 101,107,110,121	1 2	CW1 CW2	RWPS RWPS
7	Rinse D Downflow	9	IP 7, A1 IV 2,7,4,21	IP 9, A2 IV 102,107,110,121	1 2	CW1 CW2	RWPS RWPS
8	Service	120	IP 7 IV 7,11,* CSOV 1	IP 9 IV 107,111,* CSOV 6	1 2	CW1 CW2	CW3 CW4
9	Settling in T2 or T3	50	To be performed during service event		1 settling in T2 2 settling in T3		
10	Set-up for regen. To be performed during service event	35	IP 6 IV 5	IP 6 IV 105	1 2	T2 T3	T4 T4
11	Drain	3	IV 6,10,21 A1	IV 106,110,121 A2	1 2	Unit 1 Unit 2	RWPR RWPS
12	Delay	0	A1	A2			

* Flow variables: Events 2, 3, 4 and 5 - IV 14 or 114 for 75gpm or IV 13 or 113 for 150gpm or IV 12 or 112 for 200gpm.

Event 8: IV 1 or 101 for 110gpm or IV 2 or 102 for 230gpm.

** Durations based upon 2 unit operation for 1 bv of brine produced during service and flows of 200, 150, 75, 200, and 230 for Events 2, 3, 4, 5, and 8 respectively. (default flows and durations). See operation instructions for current flows and durations. Feed water at 7500 uS/cm.

Key: A - Agitator Mixer
IV - Ion exchange valve
CW - Clearwell
IX Sump - Ion exchange sump
CSOV - Chlorine solenoid valve
m - manual
DP - Dechlorination pump
IP - Ion exchange pump
T - brine tank

FIGURE 1.2 -- IX MAIN MENU

EDR/RO RECYCLE BRINE OPERATIONS MENU

See/set Macsym time 1
 Start an IX unit 2
 Change times for events 3

Status Report on IX 4
 Stop an IX unit 5
 Flush an IX unit 6
 Special option menu 7
 Start/Stop brine XFER 8
 Emergency stop both units ... 9

Type your choice (1 - 9) and [return]

MM choice = 1. See/set Macsym time.

1. Prints Macsym time to screen.
2. If "T" is typed at "press [return] to continue", then you are allowed to reset Macsym time.
3. Then return to menu (RTM).

MM choice = 2. Start IX unit.

1. User inputs unit choice.
2. Used inputs startup event.
3. User approves event times.
4. Program prestops unit.
5. Program activates unit cycle.
6. Program activates unit cycle.
7. RTM.

MM choice = 3. Change event times.

1. User inputs unit choice.
2. User approves event times.
3. RTM.

MM choice = 4. Status report in IX.

1. Unit status reported by program.
2. RTM.

MM choice = 5. Stop IX unit.

1. User inputs unit choice.
2. Program stops IX cycle action and performs cold shutdown of all motors and valves.
3. RTM.

MM choice = 6. Stop and flush IX unit.

1. User inputs unit choice.
2. User chooses start or stop flush.
3. Program stops unit.

4. Program performs requested action.
5. RTM.

MM choice = 7. Special options menu.

1. User inputs unit choice.
2. Program displays paramenter menu.
3. User inputs paramenter change choice.
4. Program prints current parameter settings.
5. User inputs paramenter change.
6. If user chooses RTM, RTM. Else go to #2.

MM choice = 8. Brine transfer.

1. User chooses which transfer to do.
2. User chooses to start or stop transfer.
3. User chooses time for transfer.
4. Program stops or performs brine transfer.
5. RTM.

MM choice = 9. Emergency stop (both units)

1. Program performs emergency stop.
2. RTM.

FIGURE 1.3 -- IX SPECIAL OPTIONS MENU

SPECIAL OPTIONS MENU, UNIT

Continue (1) or stop (2)	1
IX pumps used (7, 8, 9)	2
IX flowrate (1 or 2)	3
Regeneration Delay	4
Switch brine runs	5
Regeneration #2 flowrate	6
Regeneration #3 flowrate	7
Go back to main menu	8

Type your choice (1 - 8) and [return]

SM choice = 1. Continuous (1) or stop (2) mode.

1. The program reports current unit and mode.
2. User types in new mode.
3. RTM.

Continuous or stop mode refers to whether the unit is to operate in a continuous loop or stop at end of cycle.

SM choice = 2. IX pumps used (7, 8, 9)

1. The program reports current unit and service pump.
2. The user types in new pump.
3. RTM.

MM choice = 3. IX flowrate (1 or 2).

1. The program reports current unit and flowrate.
2. The user types in new flowrate.
3. RTM.

1 = 110 gpm, 2 = 230 gpm.

MM choice = 4. Regeneration delay.

1. The program reports current unit and regeneration delay.
2. The user types in new delay in minutes.
3. RTM.

If the unit is not in stop mode and if both units are in operation, this delay is experienced between end of cycle and Event 1. It is designed to delay Event 1 for a time period which will help coordinate the service cycle to 50 percent (no dead time).

MM choice = 5. Switch brine runs.

1. Program reports current unit and brine pipe run used.
2. User types in new pipe new pipe run choice.
3. RTM.

MM choice = 6. Regeneration #2 flowrate.

1. Program reports current unit and flowrate for Event 2.
2. User types in new flowrate.
3. RTM.

1 = 200 gpm, 2 = 150 gpm.

MM choice = 7. Regeneration #3 flowrate.

1. Program reports current unit and flowrate for Event 3.
2. User types in new flowrate.
3. RTM.

1 = 150 gpm, 2 = 75 gpm.

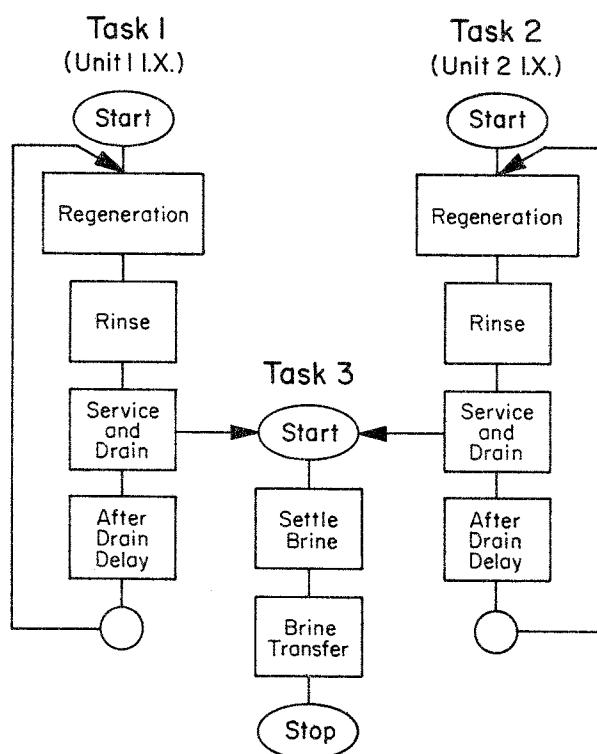
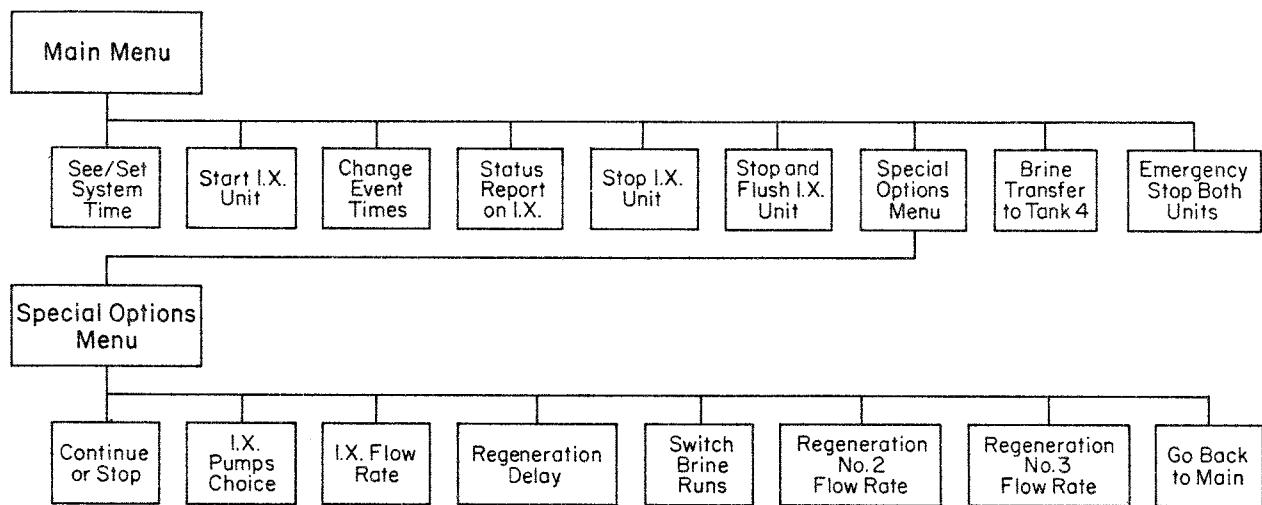
MM choice = 8. Go back to main menu.

1. Program returns screen control to main menu.

Los Banos Facility

Ion Exchange System

Programming Structure Chart



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1 REM ** A.D. MEXIX.BAS EDR/RO MACSYM 2 OPERATIONS
2 REM ** PROG; TONY C. VS HAS VERSION DATE
3 DIM V$(12) V$=TC 07/28/86
4 REM ** BEGIN MAIN PROGRAM
5 ON ERROR X1',12600,X2' REM ERROR TRAP
10 CLOSE NOMODE REM CLOSE ALL, NO MODE CHKS
20 GOSUB 10300 REM SETUP VAR.S
30 GOSUB 10200 REM SETUP RS-232'S
40 GOSUB 10100 REM TIME SET
45 TASK 1,1000 TASK 2,200 REM MAIN TASKS
50 GOSUB 10500 REM DO MAIN MENU
60 GOSUB 10600 REM ALL INPUT
70 ON A' GOTO 100,200,300,400,500,600,700,800,900
80 GO TO 50

100 REM ** SEE/SET TIME
105 GOSUB 10050 IF R'=1 THEN GOTO 50
110 PRINT "MACSYM SYSTEM TIME BELOW:"
115 PRINT :TYPE T <RET>TO RESET TIME."
120 PRINT PTIME PRINT PRINT
130 GOSUB 10800 IF A$="T" THEN GOSUB 10100
140 GOTO 50

200 REM ** START IX
220 GOSUB 11000 GOSUB 10600 REM GET UNIT
222 IF A'<1 THEN 12500
224 IF A'>2 THEN 12500
230 U'=A' IF R'=0 THEM GOSUB 11100
235 PRINT "UNIT:";U';START EVENTS( 1-";N9';" );
240 GOSUB 10600
242 IF A'<1 THEN 12500
244 IF A'>W9' THEN 12500
246 E'=A' IF R'=1 THEN GOTO 250
248 GOSUB 11200 GOSUB 10900 IF A$="Y" THEN 625
249 GOSUB 12500 GOTO 248
250 FOR I = 1 TO N9' GOSUB 10600
260 T"(U,I)=A' NEXT I
265 GOSUB 11500 REM PRESTOP
270 PRINT "STARTING UNIT:";U'
271 PTIME PRINT DOT(5,8+U')=1
272 IF U'=2 THEN 280
274 U1'=U' E1'=E' Z1'=1 ACT 1
276 GOSUB 12110(U',E',Z1') GOTO 299
280 U2'=U' E1'=E' Z1'=1 ACT 2
282 GOSUB 12111(U',E',Z1')
299 GOSUB 10800 GOTO 50

300 REM ** CHANGE EVENT TIMES
310 GOSUB 11000 GOSUB 10600
312 IF A'<1 THEN 12500
314 IF A'>2 THEN 12500
340 U'=A' IF R'=1 THEN GOTO 350
341 GOSUB 11200 GOSUB 10900 IF A$="Y" THEN 370
342 GOSUB 11250 GOTO 341
350 FOR I = 1 TO N9' GOSUB 10600
360 T"(U,I)=A' NEXT I
370 GOSUB 10050 PRINT "TIMES ARE NOW CHANGED."
399 GOSUB 10800 GOTO 50

400 REM ** REPORT IX STATUS
410 GOSUB 11400
499 GOSUB 10800 GOTO 50

500 REM ** SHUT DOWN
510 GOSUB 11000 GOSUB 10600
512 IF A'<1 THEN 12500
514 IF A'>2 THEN 12500
520 U'=A' GOSUB 11500REM SHUTDOWN
599 GOSUB 10800 GOTO 50

600 REM ** UPFLOW FLUSH
610 GOSUB 10050
615 PRINT "FLUSH ALSO STOPS UNIT." GOSUB 10050
620 GOSUB 11000 GOSUB 10600
625 IF A'<1 THEN 12500
630 IN A'>2 THEN 12500
635 U'=A' GOSUB 11500 GOSUB 10050
640 PRINT "TYPE 1 TO STOP, 2 TO START."
645 GOSUB 10600
650 IF A'<1 THEN 12500
655 IF A'>2 THEN 12500
660 E'=A' IF E'=2 THEN 680
662 PRINT "KILLINJG FLUSH, UNIT:";U'
665 IN U'=1 IF TSTATE(4)>0 THEN KILL 4
670 IN U'=2 IF TSTATE(5)>0 THEN KILL 5
675 GOSUB 11500 GOTO 699
680 PRINT "8 MIN. FLUSH, UNIT :";U'
685 IN U'=1 IF TSTATE(4)<0 THEN TASK 4,12400 ACT 4
690 IN U'=2 IF TSTATE(5)<0 THEN TASK5,12450 ACT 5
699 GOSUB 10800 GOTO 50
700 REM ** SPECIAL OPTIONS
701 GOSUB 11000 GOSUB 10600 IF A'<1 THEN 12500
702 IF A'>2 THEN 12500
703 U'=A'
704 GOSUB 10400 REM ** SPECIAL MENU
705 GOSUB 10600 IN A'=19 THEN R'=1-R' GOTO 50
706 IF A'<1 THEN GOTO 12500
707 IF A'>10 THEN GOTO 12500
708 PRINT PRINT "UNIT:";U'
709 E'=A' ON E' GOTO 710,720,730,740,750,760,770,
780,50
710 REM ** CONT. OR STOP
711 PRINT "MODE=";P1(U')
712 PRINT "CONT.(1) OR STOP.(2)"
714 GOSUB 10600 IF A'<1 THEN 12500
715 IF A'>2 THEN 12500
717 P1(U')=A' GOTO 704
720 REM ** IX PUMP
721 PRINT "IX PUMP=";P1(2+U')
722 PRINT "NEW PUMP 7/8/9:"; GOSUB 10600
723 IF A'<7 THEN 12500
724 IF A'>9 THEN 12500
725 IF U'=1 IF A'=9 THEN 12500
726 IF U'=2 IF A'=7 THEN 12500
727 IF A'=8 IF U'=1 IF P1(4)=8 THEN 12500
728 IF A'=8 IF U'=2 IF P1(3)=8 THEN 12500
729 P1(2+U')=A' GOTO 704
730 REM ** FLOW RATE
731 PRINT "IX FLOW RATE=";P1(4+U')
732 PRINT "GPM RATE 1=110,2=230:"
733 GOSUB 10600 IF A'<1 THEN 12500
734 IF A'>2 THEN 12500
735 P1(4+U')=A' PRINT FLOW RATE CHANGED." GOTO 704
740 REM ** REGEN DELAY
742 PRINT "REGEN. DELAY=";P1(6+U')
743 PRINT "DELAY(1 TO 200):";
744 GOSUB 10600 IF A'<1 THEN 12500
746 IN A'>200 THEN 12500
748 P1(6+U')=A' GOTO 704
750 REM ** REGEN#2 FLOWRATE
751 PRINT "REGEN#2 FLOW =";P1(8+U')
752 PRINT "1=200, 2=150, 3=75 GPM."
753 PRINT "NEW RATE ( 1/2/3 ):"; GOSUB 10600
754 IF A'<1 THEN 12500
755 IF A'>3 THEN 12500
756 P1(8+U')=A' PRINT "RATE CHANGED."
757 GOSUB 10800 GOTO 704
760 REM ** REGEN#3 FLOWRATE
761 PRINT "REGEN#3 FLOW =";P1(10+U')

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762 PRINT "1=200, 2=150, 3=75 GPM."
763 PRINT "NEW RATE ( 1/2/3 ):"; GOSUB 10600
764 IF A'<1 THEN 12500
765 IF A'>3 THEN 12500
766 P1(10+U')=A' PRINT "RATE CHANGED."
767 GOSUB 10800 GOTO 704
770 REM ** RINSE#4 FLOWRATE
771 PRINT "RINSE#4 FLOW =";P1(12+U')
772 PRINT "1=200, 2=150, 3=75 GPM."
773 PRINT "NEW RATE ( 1/2/3 ):"; GOSUB 10600
774 IF A'<1 THEN 12500
775 IF A'>3 THEN 12500
776 P1(12+U')=A' PRINT "RATE CHANGED."
777 GOSUB 10800 GOTO 704
780 REM ** RINSE#5 FLOWRATE
781 PRINT "RINSE#5 FLOW =";P1(14+U')
782 PRINT "1=200, 2=150, 3=75 GPM."
783 PRINT "NEW RATE ( 1/2/3 ):"; GOSUB 10600
784 IF A'<1 THEN 12500
785 IF A'>3 THEN 12500
786 P1(14+U')=A' PRINT "RATE CHANGED."
787 GOSUB 10800 GOTO 704

800 REM ** BRINE TRANSFER
802 GOSUB 10050
804 PRINT "XFER FROM T2 TO T4.....1"
806 PRINT "XFER FROM T3 TO T4.....2"
808 PRINT "BACK TO MENU.....3"
812 GOSUB 10600 IF A'<1 THEN 12500
814 U'=A' IF A'=3 THEN GOTO 50
820 PRINT "START(1) OR STOP(2) XFER"
822 GOSUB 10600 IF A'<1 THEN 12500
824 IF A'>2 THEN 12500
826 IF A'=2 THEN 850 REM ** STOP IT
828 IF U'=1 IF TSTATE(7)>0 THEN 840
829 IF U'=2 IF TSTATE(8)>0 THEN 840
830 REM** START BRINE XFER
831 PRINT "HOW LONG :"; GOSUB 10600
832 IF A'<1 THEN 12500
833 IF U'=1 THEN TASK 7,12700 ACT 7
834 IF U'=2 THEN TASK 8,12800 ACT 8
835 PRINT "STARTING BRINE XFER."
836 GOSUB 10800 GOTO 50
840 REM ** XFER ALREADY STARTED
842 PRINT "XFER ALREADY ON."
846 GOSUB 10800 GOTO 800
850 REM ** STOP BRINE XFER
851 IF U'=1 IF TSTATE(7)>0 THEN KILL 7 GOSUB 860
852 IF U'=2 IF TSTATE(8)>0 THEN KILL 8 GOSUB 870
854 PRINT "BRINE XFER KILLED." GOSUB 10800 GOTO 50
860 DOT(5,9)=1 DOT(5,11)=0 DOT(5,5)=0 DOT(6,8,9)=1
865 RETURN
870 DOT(5,10)=1 DOT(5,12)=0 DOT(5,5)=0 DOT(9,9,9)=1
875 RETURN

900 REM ** EMERGENCY SHUTDOWN
910 GOSUB 10050
920 PRINT "EMERGENCY SHUTDOWN."
930 GOSUB 10900 IF A$="N" THEN GOTO 50
940 DOT(5,0,15)=0
960 U'=1 GOSUB 11500 REM CLOSEDOWN U1
970 U'=2 GOSUB 11500 REM CLOSEDOWN U2
990 GOSUB 10800 IF A$="X" THEN STOP
999 GOTO 50

1000 REM ** UNIT 1 RO BRIN OP.S, TASK 1.
1001 IF E1' > 6 THEN 1003
1002 ON E1'-0 GOTO 1050,1100,1150,1200,1250,1300
1003 ON E1'-6 GOTO 1350,1450,1482,1482,1500,1550

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1004 PRINT "STOP AT 1000 DUE TO EVENT ERROR." STOP
1050 REM ** 1 ST REGEN,#1
1051 GOSUB 11600
1052 IF D1'=2 THEN 1052
1054 D1'=1 E1'=1
1060 DOT(5,4)=1
1063 DOT(6,12,13)=2 DOT(7,0,1)=2 DOT(7,6,7)=2
1075 DOT(7,12,13)=2 DOT(11,7,8)=2
1080 GOSUB 12010( U1', E1' )
1082 W1'=T(1,E1') IF W1'>0 THEN WAIT W1'*60-10
1085 DOT(5,4)=0 DOT(11,7,8)=1

1100 REM **** 2ND REGEN,#2
1101 GOSUB 11600
1102 IF D1'=2 THEN 1102
1104 D1'=1 E1'=2
1110 DOT(5,4)=1
1112 GOSUB 1800 REM FLOWRATE
1115 DOT(6,6,7)=2 DOT(6,12,13)=2
1125 DOT(7,12,13)=2 DOT(2,0,1)=2
1130 GOSUB 12010( U1', E1' )
1132 W1'=T'(1,E1') IF W1'>0 THEN WAIT W1'*60-10
1135 DOT(5,4)=0 DOT(2,0,1)=1
1150 REM **** 3RD REGEN,#3
1151 GOSUB 11600
1152 IF D1'=2 THEN 1152
1154 D1'=1 E1'=3
1160 DOT(5,0)=1
1162 GOSUB 1800
1165 DOT(6,6,7)=2 DOT(6,12,13)=2
1175 DOT(8,0,1)=2 DOT(2,0,1)=2
1180 GOSUB 12010( U1', E1' )
1182 W1'=T'(1,E1') IF W1'>0 THEN WAIT W1'*60-10
1185 DOT(5,0)=0 DOT(2,0,1)=1 DOT(8,0,1)=1 D1'=0

1200 REM **** RINSE A,#4
1201 GOSUB 11600
1202 IF D2'=2 THEN 1202
1204 D2'=1 E1'=4
1210 DOT(5,P1(3)-1)=1
1215 GOSUB 1800
1220 DOT(6,4,5)=2 DOT(6,6,7)=2
1225 DOT(6,12,13)=2 DOT(2,0,1)=2
1230 GOSUB 12010(U1',E1' )
1232 W1'=T'(1,E1') IF W1'>0 THEN WAIT W1'*60-10
1235 DOT(5,P1(3)-1)=0 DOT(2,0,1)=1
1250 REM **** RINSE B,#5
1251 GOSUB 11600
1252 IF D2'=2 THEN 1252
1254 D2'=1 E1'=5
1260 DOT(5,P1(3)-1)=1
1265 GOSUB 1800
1270 DOT(6,4,5)=2 DOT(6,6,7)=2
1275 DOT(6,12,13)=2 DOT(2,0,1)=2
1280 GOSUB 12010(U1',E1' )
1282 W1'=T'(1,E1') IF W1'>0 THEN WAIT W1'*60-10
1285 DOT(5,P1(3)-1)=0 DOT(2,0,1)=1
1300 REM **** RINSE C,#6
1301 GOSUB 11600
1302 IF D2'=2 THEN 1302
1304 D2'=2 E1'=6
1310 DOT(5,P1(3)-1)=1
1315 DOT(6,0,1)=2 DOT(6,12,13)=2
1325 DOT(7,2,3)=2 DOT(11,5,6)=2
1330 GOSUB 12010(U1',E1' )
1332 W1'=T'(1,E1') IF W1'>0 THEN WAIT W1'*60-10
1335 DOT(5,P1(3)-1)=0 DOT(11,5,6)=1
1350 REM **** RINSE D,#7

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1351 GOSUB 11600
1352 IF D2'=2 THEN 1352
1354 D2'=1 E1'=7
1360 DOT(5,P1(3)-1)=1 DOT(5,8+1)=0
1365 DOT(6,2,3)=2 DOT(6,12,13)=2
1375 DOT(7,2,3)=2 DOT(11,5,6)=2
1380 GOSUB 12010(U1',E1')
1382 W1'=T'(1,E1') IF W1'>0 THEN WAIT W1'*60-10
1385 DOT(5,P1(3)-1)=0 DOT(11,5,6)=1 D2'=0

1450 REM **** SERVICE
1452 GOSUB 11600
1454 IF S'=2 THEN 1454
1455 S'=1 E1'=8
1460 DOT(5,P1(3)-1)=1 GOSUB 1900
1465 DOT(8,8)=1 DOT(6,12,13)=2
1470 DOT(7,4,5)=2
1480 GOSUB 12010(U1',E1')
1482 IF P'=2 THEN 1482
1483 IF E1'>8 THEN E3'=E1' S'=1
1484 TASK 3,3000 ACT 3
1486 W1'=T'(1,E1') IF W1'>0 THEN WAIT W1'*60-10
1490 DOT(5,P1(3)-1)=0 DOT(8,8)=0

1500 REM **** DRAIN,#11
1501 GOSUB 11600
1502 IF S'=2 THEN 1502
1504 IF P'=1 THEN 1504
1506 E1'=11 S'=1
1515 DOT(6,10,11)=2 DOT(7,2,3)=2
1525 DOT(11,5,6)=2
1530 GOSUB 12010(U1',E1')
1532 W1'=T'(1,E1') IF W1'>0 THEN WAIT W1'*60-10
1535 DOT(11,5,6)=1

1550 REM **** AFTER DRAIN DELAY, UNLESS SUSPEND.
1552 GOSUB 11600 REM CLOSE VALVES
1560 E1'=12 IF P1(1)=2 THEN GOTO 1600
1570 GOSUB 12010( U1', E1' )
1580 W1'=T'(1,12) IF W1'>0 THEN WAIT W1'*60-10
1585 S'=0 IF U2'=0 THEN GOTO 1050
1587 PRINT "UNIT 1 COORD. DELAY=";P1(7)
1590 IF P1(7)>0 THEN WAIT P1(7)*60
1595 GOTO 1050
1600 REM **** SUSPEND UNIT 1 BPS
1610 W1'=0 GOSUB 12010( U1', E1' )
1615 GOSUB 12110( U1', E1', E1' )
1620 U1'=0 DOT(5,9)=0 C(3)=0 S'=0
1625 PRINT "UNIT 1 SELF-SUSPEND." PTIME PRINT
1630 SUSPEND SELF

1800 REM ** SUBR: OPEN FLOW RATE
1802 W1'=P1( 8+(E1'*2)-3 )
1810 IF W1' = 1 THEN DOT(7,6,7)=2
1820 IF W1' = 2 THEN DOT(7,8,9)=2
1830 IF W1' = 3 THEN DOT(7,10,11)=2
1849 RETURN
1900 REM ** SUBR: OPEN FLOW VALVE
1910 IF P1(5) = 1 THEN DOT(6,0,1)=2
1920 IF P1(5) = 2 THEN DOT(6,2,3)=2
1930 RETURN

2000 REM ** UNIT 2 RO BRINE OP.S TASK 2.
2001 IF E2' > 6 THEN 2003
2002 ON E2'-0 GOTO 2050,2100,2150,2200,2250,3300
2003 ON E2'-6 GOTO 2350,2450,2482,2482,2500,2550
2004 PRINT "STOP AT 2000 DUE TO EVENT ERROR." STOP

2050 REM **** FIRST REGEN,#1

2051 GOSUB 11650
2052 IF D1'=1 THEN 2052
2054 D1'=2 E2'=1
2060 DOT(5,4)=1
2065 DOT(9,12,13)=2 DOT(10,0,1)=2 DOT(10,6,7)=2
2075 DOT(10,12,13)=2 DOT(11,11,12)=2
2080 GOSUB 12010( U2', E2' )
2082 W2'=T(2,E2') IF W2'>0 THEN WAIT W2'*60-10
2085 DOT(5,4)=0 DOT(11,11,12)=1
2100 REM **** 2ND REGEN,#2
2101 GOSUB 11650
2102 IF D1'=1 THEN 2102
2104 D1'=2 E2'=2
2110 DOT(5,4)=1
2112 GOSUB 2800
2115 DOT(9,6,7)=2 DOT(9,12,13)=2
2125 DOT(10,12,13)=2 DOT(2,2,3)=2
2130 GOSUB 12010( U2', E2' )
2132 W2'=T(2,E2') IF W2'>0 THEN WAIT W2'*60-10
2135 DOT(5,4)=0 DOT(2,2,3)=1
2150 REM **** 3RD REGEN,#3
2151 GOSUB 11650
2152 IF D1'=1 THEN 2152
2154 D1'=2 E2'=3
2160 DOT(5,0)=1
2162 GOSUB 2800
2165 DOT(9,6,7)=2 DOT(9,12,13)=2
2175 DOT(2,2,3)=2 DOT(8,2,3)=2
2180 GOSUB 12010( U2', E2' )
2182 W2'=T(2,E2') IF W2'>0 THEN WAIT W2'*60-10
2185 DOT(5,0)=0 DOT(2,2,3)=1 DOT(8,2,3)=1 D1'=0

2200 REM **** RINSE A,#4
2201 GOSUB 11650
2202 IF D2'=1 THEN 2202
2204 D2'=2 E2'=4
2210 DOT(5,P1(4)-1)=1
2215 GOSUB 2800
2220 DOT(9,4,5)=2 DOT(9,6,7)=2
2225 DOT(9,12,13)=2 DOT(2,2,3)=2
2230 GOSUB 12010(U2',E2')
2232 W2'=T(2,E2') IF W2'>0 THEN WAIT W2'*60-10
2235 DOT(5,P1(4)-1)=0 DOT(2,2,3)=1
2250 REM **** RINSE B,#5
2251 GOSUB 11650
2252 IF D2'=1 THEN 2252
2254 D2'=2 E2'=5
2260 DOT(5,P1(4)-1)=1
2265 GOSUB 2800
2270 DOT(9,4,5)=2 DOT(9,6,7)=2
2275 DOT(9,12,13)=2 DOT(2,2,3)=2
2280 GOSUB 12010(U2',E2')
2282 W2'=T(2,E2') IF W2'>0 THEN WAIT W2'*60-10
2285 DOT(5,P1(4)-1)=0 DOT(2,2,3)=1
2300 REM **** RINSE C,#6
2301 GOSUB 11650
2302 IF D2'=1 THEN 2302
2304 D2'=2 E2'=6
2310 DOT(5,P1(4)-1)=1
2315 DOT(9,0,1)=2 DOT(9,12,13)=2
2325 DOT(10,2,3)=2 DOT(11,9,10)=2
2330 GOSUB 12010(U2',E2')
2332 W2'=T(2,E2') IF W2'>0 THEN WAIT W2'*60-10
2335 DOT(5,P1(4)-1)=0 DOT(11,9,10)=1
2350 REM **** RINSE D,#7
2351 GOSUB 11650
2352 IF D2'=1 THEN 2352
2354 D2'=2 E2'=7
2360 DOT(5,P1(4)-1)=1 DOT(5,8+2)=0

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2365 DOT(9,2,3)=2 DOT(9,12,13)=2
2375 DOT(10,2,3)=2 DOT(11,9,10)=2
2380 GOSUB 12010(U2',E2')
2382 W2'=T'(2,E2') IF W2'>0 THEN WAIT W2'*60-10
2385 DOT(5,P1(4)-1)=0 DOT(11,5,6)=1 D2'=0

2450 REM **** SERVICE,#8
2452 GOSUB 11650
2454 IF S'=1 THEN 2454
2455 S'=2 E2'=8
2460 DOT(5,P1(4)-1)=1 GOSUB 2900
2465 DOT(8,9)=1 DOT(10,4,5)=2
2470 DOT(9,12,13)=2
2480 GOSUB 12010(U2',E2')
2482 IF P'=1 THEN 2482
2483 IF E2'>8 THEN E3'=E2' S'=2
2484 TASK 3,3000 ACTIVATE 3
2486 W2'=T'(2,E2') IF W2'> 0 THEN WAIT W2'*60-10
2490 DOT(5,P1(4)-1)=0 DOT(8,9)=0

2500 REM **** DRAIN,#11
2501 GOSUB 11650
2502 IF S'=1 THEN 2502
2504 IF P'=2 THEN 2504
2506 E2'=11 S'=2
2515 DOT(9,10,11)=2 DOT(10,2,3)=2
2525 DOT(11,9,10)=2
2530 GOSUB 12010(U2',E2')
2532 W2'=T'(2,E2') IF W2'> 0 THEN WAIT W2'*60-10
2535 DOT(11,9,10)=1

2550 REM **** AFTER DRAIN DELAY, OR SUSPEND BELOW.
2552 GOSUB 11650 REM CLOSE VALVES
2560 E2'=12 IF P1(2)=2 THEN GOTO 2600
2570 GOSUB 12010( U2', E2' )
2580 W2'=T'(2,E2') IF W2'> 0 THEN WAIT W2'*60-10
2585 S'=0 IF U1'=0 THEN GOTO 2050
2587 PRINT "UNIT 2 COORD. DELAY=";P1(8)
2590 IF P1(8)>0 THEN WAIT P1(8)*60-10
2595 GOTO 2050
2600 REM **** SUSPEND UNIT 2
2610 W2'=0 GOSUB 12010( U2', E2' )
2615 GOSUB 12110( U2', E2', E2')
2620 U2'=0 DOT(5,10)=0 C(4)=0 S'=0
2625 PRINT "UNIT 2 SELF-SUSPEND." PTIME PRINT
2630 SUSPEND SELF

2800 REM ** SUBR: RINSE FLOW RATE
2802 W2'=P1( 8+(E2'*2)-2 )
2810 IF W2' = 1 THEN DOT(10,6,7)=2
2820 IF W2' = 2 THEN DOT(10,8,9)=2
2830 IF W2' = 3 THEN DOT(10,10,11)=2
2849 RETURN
2900 REM ** SUBR: OPEN FLOW VALVE
2910 IF P1(6) = 1 THEN DOT(9,0,1)=2
2920 IF P1(6) = 2 THEN DOT(9,2,3)=2
2930 RETURN

3000 REM ** PREP FOR REGENERATION, TASK#3
3002 P'=S'
3004 IF E3'=10 THEN 3200
3100 REM ** SETTLING,#9
3110 E3' DOT(5,8+P1')=0
3120 GOSUB 3900 IF W3'>0 THEN WAIT W3'*60
3200 E3'=10 REM** SETUP,#10
3210 DOT(5,11,12)=0 DOT(3+3*P',8,9)=2
3220 DOT(5,10+P')=1 DOT(5,5)=1
3230 GOSUB 3900 IF W3'>0 THEN WAIT W3'*60
3240 DOT(3+3*P',8,9)=1

3245 DOT(5,10+P')=0 DOT(5,5)=0
3300 REM ** DONE WITH STEP
3310 PRINT "PREP:","DONE." PTIME PRINT
3312 PRINT:7 "PREP:","DONE."; PNT:7 13
3314 PTIME:7 PNT:7 13
3320 DOT(5,8+P')=1 P'=0 E3'=0 KILL SELF
3900 REM ** ANNOUNCE & WAIT
3950 RESERVE:9 RESERVE:7 W3'=T'(P',E3')
3960 PRINT :9 "UNIT,";P";",EVENT:";E3";
3962 PRINT :7 "UNIT,";P";",EVENT:";E3"; PNT:7 13
3970 PTIME :9 PRINT :9 "DUR,";W3';
3972 PTIME :7 PRINT :7 "DUR,";W3'; PNT:7 13
3980 PNT : 7 13 RELEASE:7
3982 PNT : 9 13 RELEASE:9
3999 RETURN

10000 REM ** SETUP PROPER MODES, HOMCLR.
10010 CLOSE NOMODE
10020 PNT 15 PRINT PRINT RETURN
10050 PNT 14 PRINT PRINT RETURN
10100 REM ** GET THE TIME AND DATE SUBR.
10110 GOSUB 10050 PRINT " "
10115 PRINT "TYPE IN THE DATE LIKE THIS :"
10120 PRINT "MM,DD,YY THEN TAP <RETURN>"
10130 INPUT X1',X2',X3' STIME X1',X2',X3'
10140 GOSUB 10050
10145 PRINT "TYPE IN THE TIME LIKE THIS :"
10150 PRINT "HH,MM,SS THEN TAP <RETURN>"
10160 INPUT X1',X2',X3' STIME X1',X2',X3'
10199 RETURN
10200 REM ** SETUP FILES
10210 OPENR :3 "$QTE3" ECHO OFF :3 OPENW :5 "$QTO:3"
10220 OPENW :9: "QTO:2" REM LOGGING PORT 54
10225 OPENW 7: "QTO:0" REM PRINTING PORT
10230 RETURN
10300 REM ** INIT. ARRAYS & VARIABLES
10310 DIM A$(4), K$(4), T'(2,12), C(16), P1(16)
10320 I=0 W1'=0 W2'=0
10330 R'=0 S'=0 P'=0 X'=0 Y'=0 Z'=0
10340 U'=0 U1'=0 U2'=0 Z1'=0
10345 X'=0 X1'=0 X2'=0 X3'=0 X4'=0
10350 E'=0 E1'=0 E2'=0 E3'=0 E4'=0
10352 D1'=0 D2'=0 N9'=12 R'=0
10360 RESTORE REM READ IN PARAM ARRY
10362 FOR I = 1 TO 16 READ P1(I) NEXT I
10364 DATA 1,1,7,9,2,2,0,0,1,1,2,2,3,3,1,1
10370 REM ** CLEAR COND. ARRAY
10372 FOR I = 1 TO 16 C(I)=0 NEXT I
10374 FOR I = 1 TO N9' REM READ DEF. TIMES
10376 READ T'(1,I), T'(2,I) NEXT I
10380 REM DEFAULT TIMES FOR EVENTS
10381 DATE 13,13
10382 DATA 40,40
10383 DATA 09,09
10384 DATA 06,06
10385 DATA 05,05
10386 DATA 05,05
10387 DATA 09,09
10388 DATA 120,120
10389 DATA 50,50
10390 DATA 35,35
10391 DATA 3,3
10392 DATA 0,0
10398 RESTART MAIN,1
10399 RETURN
10400 REM ** SPECIAL OPTIONS MENU
10402 GOSUB 10050 PRINT "SPEC. OPTIONS MENU, UNIT=;U"
10404 PRINT "-----"
10410 PRINT "CONT.(1) OR STOP (2).....1"

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10420 PRINT "IX PUMPS USED (7,8,9)....2"
10430 PRINT "IX FLOW RATE (1 OR 2)....3"
10440 PRINT "REGENERATION DELAY.....4"
10450 PRINT "REGEN. #2 FLOWRATE.....5"
10460 PRINT "REGEN. #3 FLOWRATE.....6"
10470 PRINT "RINSE #4 FLOWRATE.....7"
10480 PRINT "RINSE #5 FLOWRATE.....8"
10490 PRINT "GO BACK TO MAIN MENU.....9"
10495 PRINT "TYPE YOUR CHOICE:====>"; RETURN
10500 REM ** OPERATOR MENU
10505 ON R'+1 GOSUB 10020,10050
10510 PRINT "EDR/RO RECYC. BRINE IS OP.S MENU."
10515 PRINT "VERS:;VS; TIME:"; PTIME PRINT
10520 IF R'=1 THEN PRINT "REMOTE CONTROL=ON." RETURN
10525 PRINT "_____"
10530 PRINT "SEE/SET MACSYM TIME.....1"
10535 PRINT "START AN LX. UNIT.....2"
10540 PRINT "CHANGE TIMES FOR EVENTS.....3"
10545 PRINT "STATUS REPORT ON IX.....4"
10550 PRINT "STOP AN LX. UNIT.....5"
10555 PRINT "FLUSH IX UNIT TO IX SUMP.....6"
10560 PRINT "SPECIAL OPTIONS MENU.....7"
10562 PRINT "START/STOP BRINE XFER TO T4.....8"
10564 PRINT "EMERGENCY STOP BOTH UNITS.....9"
10570 PRINT "TYPE YOUR CHOICE (1-9) AND <RETURN>."
10580 RETURN
10600 REM ** SUBR: TAKE KEY OF HP INPUT
10610 IF R'=1 THEN 10650
10620 INPUT A$ IF A$="" THEN A$="0"
10625 IF A$="M" THEN RESTE SUB GOTO 50
10630 A = VAL(A$) A'= VAL(A$)
10640 RETURN
10650 REM ** REMOTE ENTRY
10660 GOSUB 10700 REM ** REMOTE ENTRY
10670 INPUT:3 A$ IF A$"" THEN A$="0"
10675 IF A$="M" THEN RESET SUB GOTO 50
10680 A = VAL(A$) A'= VAL(A$)
10690 RETURN
10700 REM ** SUBR: REJECT NOISE, EAT KEY
10710 PRINT:5 "GO!!"
10720 INPUT :3 K$
10725 IF LEN(K$)<4 THEN GOTO 10720
10730 IF K$="OK??" THEN PRINT:5 "OK!!" GOTO 10700
10740 IF K$>"KEY!" THEN 10720
10750 RETURN
10800 REM ** SUBR: PRESS <RETURN>
10810 IF R'=1 THEN RETURN
10820 INPUT "PRESS <RETURN> TO CONTINUE."A$
10825 IF A$="M" THEN RESET SUB GOTO 50
10830 RETURN
10900 REM ** SUBR: TYPE Y OR N
10920 INPUT "OK? Y FOR YES, N FOR NO:" A$
10920 IN A$<>"Y" IF A$<>"N" THEN PNT T GOTO 10900
10930 RETURN

11000 REM ****UNIT # MENU
11010 GOSUB 1005 PRINT "PICK THE UNIT YOU WANT."
11020 PRINT "( TYPE 1 OR 2, TAP <RETURN>.)"
11040 RETURN
11100 REM **** EVENT # MENU
11110 GOSUB 10020 PRINT "START EVENT, UNIT:";U'
11120 FOR I = 1 TO N9'
11130 GOSUB 11410(I) PRINT I
11140 NEXT I PRINT RETURN

11200 REM **** APPROVE EVENT TIMES MENU
11210 GOSUB 10020 PRINT "APPROVE THE TIMES BELOW."
11220 PRINT "TYPE N <RETURN> TO CHANGE A TIME."
11230 FOR I = 1 TO N9' PRINT I;""; GOSUB 11310(I)

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11240 PRINT T'(U',I) NEXT I PRINT
11245 RETURN
11250 REM ** CHANGE AN EVENT
11255 PRINT "EVENT # TO CHANGE:;";
11260 GOSUB 10600
11262 IF A'<1 THEN RESET SUB GOTO 12500
11264 IF A'>N9' THEN RESET SUB GOTO 12500
11266 X1'=A'
11270 REM ** CHANGE TIME
11275 PRINT "NEW EVENT TIME:;";
11280 GOSUB 10600
11282 IF A'<0 THEN RESET SUB GOTO 12500
11284 IF A'>300 THEN RESET SUB GOTO 12500
11286 T'(U',X1')=A'
11290 RETURN

11300 REM **** PRINT THE ITH EVENT
11310 DECLARE(X)
11315 IF X>6 THEN 11325
11320 ON X-0 GOTO 11350,11351,11352,11353,11354,11355
11325 ON X-6 GOTO 11360,11361,11362,11363,11364,11365
11350 PRINT "RECYC. BRINE REGEN#1...."; RETURN
11351 PRINT "RECYC. BRINE REGEN#2...."; RETURN
11352 PRINT "FRESH BRINE REGEN....."; RETURN
11353 PRINT "RINSE A (CW TO T2,T3)...."; RETURN
11354 PRINT "RINSE B (CW TO T2,T3)...."; RETURN
11355 PRINT "RINSE C (CW TO IX SUMP)...."; RETURN
11360 PRINT "RINSE D (CW TO RWPS)...."; RETURN
11361 PRINT "IX MAIN SERVICE....."; RETURN
11362 PRINT "SETTLING IN T2 OR T3...."; RETURN
11363 PRINT "REGEN SETUP(T2,T3 TO T4)."; RETURN
11364 PRINT "IX UNIT DRAIN....."; RETURN
11365 PRINT "AFTER DRAIN DELAY....."; RETURN

11400 REM **** REPORT UNIT STATUS
11410 GOSUB 10050 PRINT "CYCLE STATUS FOR LX."
11412 PRINT "TIME:";PTIME PRINT PRINT
11420 PRINT "UNIT 1:"; IF U1'=1 THEN PRINT "ON ";
11422 IF U1'=0 THEN PRINT "OFF";
11424 PRINT ", AT EVENT#";E1'
11426 PRINT "EVENT BEGAN:";C(7);";";C(9)
11427 IF P'=1 THEN PRINT "PREP ON, EVENT:";E3'
11428 PRINT "DUR: ";C(11)
11430 PRINT PRINT "UNIT 2:";
11431 IF U2'=2 THEN PRINT "ON ";
11432 IF U2'=0 THEN PRINT "OFF";
11434 PRINT ", AT EVENT#";E2'
11436 PRINT "EVENT BEGAN:";C(8);";";C(10)
11437 IF P'=2 THEN PRINT "PREP ON, EVENT:";E3'
11438 PRINT "DUR: ";C(12)
11440 IF R'=0 THEN RETURN
11450 REM ** SEND STATUS TO HP-1000
11452 CTIME X1',X2',X3'
11454 C(1)=X1' C(2)=X2'
11455 FOR I = 1 TO 12
11460 GOSUB 10700 PRINT:5 C(I)
11499 NEXT I RETURN
11500 REM **** STOP IX OP.S
11501 GOSUB 10050 PRINT "STOPPING IX UNIT:";U'
11502 PRINT "TIME:";PTIME PRINT
11503 E4'=E1' Z1'=0 IF U'=2 THEN E4'=E2'
11504 GOSUB 12110(U',E4',Z1')
11505 IF P'=U' THEN GOSUB 11900
11506 ON U' GOSUB 11510,11550
11507 DOT(5,8+U")=0 C(2+U")=0
11508 RETURN
11510 REM **** SHUTDOWN UNIT 1
11512 KILL 1 TASK 1,1000
11515 GOSUB 11800 GOSUB 11600

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11525 U1'=0 E1'=0 GOSUB 11700
11530 RETURN
11550 REM **** SHUTDOWN UNIT 2
11552 KILL 2 TASK 2,2000
11555 GOSUB 11850 GOSUB 11650
11565 U2'=0 E2'=0 GOSUB 11750
11570 RETURN
11600 REM ** CLOSE VALVES, UNIT 1
11610 DOT(6,0,15)=22101 DOT(7,0,15)=21845
11620 DOT(8,0,1)= 1 DOT(11,5,8)=5
11630 DOT(2,0,1)= 1 DOT(2,4,5)=1
11635 IF TSTATE(7)<0 THEN DOT(6,8,9)=1
11640 WAIT 10 RETURN
11650 REM ** CLOSE VALVES, UNIT 2
11660 DOT(9,0,15)=22101 DOT(10,0,15)=21845
11670 DOT(11,0,3)= 5 DOT(11,9,12)=5
11680 DOT(2,2,3)= 1 DOT(2,6,7)=1 DOT(8,2,3)=1
11685 IF TSTATE(8)<0 THEN DOT(9,8,9)=1
11690 WAIT 10 RETURN
11700 REM *** RELEASE UNIT 1
11710 DOT(6,0,15)=0 DOT(7,0,15)=0
11720 DOT(8,0,1)=0 DOT(11,5,8)=0
11730 DOT(2,0,1)=0 DOT(2,4,5)=0
11740 RETURN
11750 REM *** RELEASE UNIT 2
11760 DOT(9,0,15)=0 DOT(10,0,15)=0
11770 DOT(11,0,3)=0 DOT(11,9,12)=0
11780 DOT(2,2,3)=0 DOT(2,6,7)=0 DOT(8,2,3)=0
11790 RETURN
11800 REM ** STOP UNIT 1 PUMPS
11810 IF D1'=1 THEN D1'=0 DOT(5,4)=0 DOT(5,2)=0
11820 IF D2'=1 THEN D2'=0 DOT(5,P1(3)-1)=0
11830 IF S'=1 THEN S'= 0 DOT(5,P1(3)-1)=0 DOT(8,8)=0
11840 RETURN
11850 REM ** STOP UNIT 2 PUMPS
11860 IF D1'=2 THEN D1'=0 DOT(5,4)=0 DOT(5,1)=0
11870 IF D2'=2 THEN D2'=0 DOT(5,P1(4)-1)=0
11880 IF S'=2 THEN S'= 0 DOT(5,P1(4)-1)=0 DOT(8,9)=0
11890 RETURN
11900 REM ** STOP PREP PUMPS
11905 DOT(5,10+P')=0
11910 IF E3'=10 THEN DOT(5,5)=0
11930 KILL 3 E3'=0 P'=0
11940 RETURN
12000 REM **** ANNOUNCE THE UNIT AND EVENT
12010 DECLARE(X',Y')
12012 IF X4'=1 THEN 12012
12015 X4'=1 GTIME X1',X2',X3'
12020 C(1)=X1' C(2)=X2' C(3)=X'
12025 C(4+X') = Y' C(6+X')=X1'
12030 C(8+X') = X2' C(10+X')= T'(X',Y') PRINT
12035 PRINT "UNIT: ";X';" STARTED EVENT: ";Y'
12040 PRINT "TIME: ";PTIME PTINT " "
12042 IF X'>0 IF Y'>0 THEN PRINT "DUR: ";T'(X',Y')
12045 RESERVE : 9 RESERVE : 7 IF Y'=1 THEN PNT:7 13
12050 PRINT :7 "UNIT: ";X';" ENENT: ";Y'; PNT:7 13
          PTIME:7
12052 PRINT :9 "UNIT: ";X';" STARTED EVENT: ";Y';PTIME:9
12055 IF X'>0 IF Y'>0 THEN PRINT :7 "DUR: ";T'(X',Y');
12057 IF X'>0 IF Y'>0 THEN PRINT :9 "DUR: ";T'(X',Y');
12060 PNT:9 13 RELEASE: 9 PNT:7 13 RELEASE:7 X4'=0
12065 RETURN

12100 REM **** ANNOUNCE UNIT STARTUP/SHUTDOWN
12110 DECLARE(X',Y',Z_) REM UNIT,EVENT,START/STOP
12120 RESERVE:9 RESERVE:7
12130 IF Z'=0 THEN PRINT:7 "UNIT: ";X';" SHUTDOWN: ";
          SHUTDOWN:"; PNT:7 1
12132 IF Z'=0 THEN PRINT:9 "UNIT: ";X';"

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          SHUTDOWN EVENT:";Y';
12140 IF Z'=1 THEN PRINT:7 "UNIT: ";X';"
          STARTUP EVENT:";Y';
12142 IF Z'=1 THEN PRINT:9 "UNIT: ";X';"
          STARTUP EVENT:";Y';
12150 PTIME:9 PTIME:7 PNT:9 13 PNT:7 13
12160 RELEASE:9 RELEASE:7 RETURN
12200 REM **** KEYS
12210 GOSUB 10050
12215 PRINT "KEYBOARD OPERATIONS MODE."
12220 PRINT "ORDER HP-1000 REMOTE CONTROL"
12230 PRINT "FROM THE MAIN MENU."
12240 PNT 7 RETURN
12250 GOSUB 10050
12255 PRINT "REMOTE OPERATIONS MODE."
12260 PRINT "REGAIN KEYBOARD CONTROL FROM"
12270 PRINT "HP-1000 MAIN MENU, OR ABORT"
12280 PRINT "BY TYPING CONTROL-A."
12299 PNT 7 RETURN

12300 REM **** UNIT STARTUP HELP
12310 GOSUB 10050
12320 PRINT "TO START THE IX SYSTEM, YOU"
12330 PRINT "MUST PICK THE UNIT, THE EVENT"
12340 PRINT "TO START THE IX CYCLE WITH, "
12350 PRINT "THEN APPROVE OR CHANGE EACH "
12360 PRINT "EVENT TIME FOR THE IX CYCLE. "
12370 PRINT "THE IX UNIT IS THEN STARTED."
12380 PRINT PRINT RETURN

12400 REM ** FLUSH UNIT 1
12405 GOSUB 11600 DOT(5,P1(3)-1)=1
12410 DOT(6,4,5)=2 DOT(6,12,13)=2 DOT(7,0,1)=2
12415 DOT(7,6,7)=2 DOT(11,7,8)=2 WAIT 8*60
12420 DOT(5,P1(3)-1)=0 GOSUB 11600 PRINT
12425 PRINT "DONE WITH FLUSH." PNT 7 WAIT 5
12430 KILL SELF
12450 REM ** FLUSH UNIT 2
12455 GOSUB 11650 DOT(5,P1(4)-1)=1
12460 DOT(9,4,5)=2 DOT(9,12,13)=2 DOT(10,0,1)=2
12465 DOT(10,6,7)=2 DOT(11,11,12)=2 WAIT 8*60
12470 DOT(5,P1(4)-1)=0 GOSUB 11650 PRINT
12475 PRINT "DONE WITH FLUSH." PNT 7 WAIT 5
12480 KILL SELF
12500 REM ** GENERAL ENTRY ERROR
12510 PNT 14 PRINT PRINT "DATA ENTRY ERROR."
12520 PNT 7 GOSUB 10800 GOTO 50
12600 REM ** GENERAL ERROR TRAP
12605 PRINT "ERROR: ";X1';" LINE: ";X2' PNT 7
12610 IF X1'=158 IF X2'=274 THEN TASK 1,1000
12615 IF X1'=158 IF X2'=280 THEN TASK 2,2000
12699 WAIT 1 PNT 7 WAIT 1 PNT 7 WAIT 99 GOTO 50
12700 REM ** T2->T4
12710 DOT(5,9)=0 DOT(5,11,12)=0 DOT(6,8,9)=2
12720 DOT(5,11)=1 DOT(5,5)=1
12730 PRINT "XFER:1 FOR: ";A' PRINT 7 "XFER:1 FOR: ";A'
12740 PTIME PRINT PTIME:7 PRINT:7 " " WAIT A'*60
12750 DOT(5,9)=1 DOT(5,11)=0 DOT(5,5)=0 DOT(6,8,9)=1
12760 PRINT "XFER DONE." PNT 7 KILL SELF
12800 REM ** T3->T4
12810 DOT(5,10)=0 DOT(5,11,12)=0 DOT(9,8,9)=2
12820 DOT(5,12)=1 DOT(5,5)=1
12830 PRINT "XFER:2 FOR: ";A' PRINT 7 "XFER:2 FOR: ";A'
12840 PTIME PRINT PTIME:7 PRINT:7 " " WAIT A'*60
12850 DOT(5,10)=1 DOT(5,12)=0 DOT(5,5)=0 DOT(9,8,9)=1
12860 PRINT "XFER DONE." PNT 7 KILL SELF
19500 REM ZZZZZZZZZZ

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**ANALOG DEVICES COMPUTER
DEVICE CONNECTION TO ANALOG COMPUTER
MONITORING CARDS**

April 21, 1986

Empty slots: 1, 12, 13, 14, and 15.

Card Slot	Device	Channel Input	Comments
0	Flow Sensor IX1	0	on IX Unit 1
	Cond. " IX1	1	on IX Unit 1
	Flow " IX2	2	on IX Unit 2
	Cond. " IX2	3	on IX Unit 2
	Level " IX1	4	tank T6 level
	Level " IX2	5	tank T7 level
	VCE	6	for future VCE tank
	vacant	7 thru 15	spare
3	Open	0 thru 3	spare
	PP1 pump	4	status of MP pump - MP SYSTEM not in service
	PP2 pump	5	status of MP pump - MP SYSTEM not in service
	PP3 pump	6	status of MP pump - MP SYSTEM not in service
	PP4 pump	7	status of MP pump - MP SYSTEM not in service
	Vacant	8 thru 15	
4	vacant	0 thru 3	spare
	SOV1	4	status SOV1
	SOV2	5	status SOV2 - MP system not in service
	SOV3	6	status SOV3 - MP system not in service
	SOV4	7	status SOV4 - Cl2 injection controlled by FP1
	SOV5	8	status SOV5 - Cl2 injection controlled by FP2
	SOV6	9	status SOV6
	SOV7	10	status SOV7
	SOV8	11	status SOV8
	SOV9	12	status SOV9 -Cl2 inject'n controlled by chlorinator
	vacant	13 thru 15	spare
5	Ion Pump 1	0	near tank T1
	Ion Pump 2	1	" " T7
	Ion Pump 3	2	" " T6
	Ion Pump 4	3	" " T5
	Ion Pump 5	4	" " T4
	Ion Pump 6	5	near tanks T2 and T3
	Ion Pump 7	6	near clearwell CW1
	Ion Pump 8	7	near clearwells CW1 and CW2
	Ion Pump 9	8	near clearwell CW2
	Agitator A1	9	near tank T2
	Agitator A2	10	" " T3
	Level sensor T2	11	Level cutoff sensor in T2 for IP6
	Level sensor T3	12	Level cutoff sensor in T3 for IP6
	PP1 pump	13	pond effluent pump - MP system not in service
	PP1 pump	14	pond effluent pump - MP system not in service
	vacant	15	spare

ANALOG DEVICES COMPUTER
 DEVICE CONNECTION TO ANALOG COMPUTER
 CONTROL CARDS

April 21, 1986

Card		Chan. Output				Card		Chan. Output			
Slot	Device	close	open	Comments		Slot	Device	close	open	Comments	
2	Ion Valve 23	0	1	between tanks T2 and T3		9	Ion Valve 101	0	1	on IX Unit 2	
	123	2	3	between tanks T2 and T3		102		2	3	" "	
	24	4	6			103		4	5	" "	
	124	6	8			104		6	7	" "	
	vacant	8 thru 15		spare		105		8	9	" "	
6	Ion Valve 1	0	1	on IX Unit 1		106		10	11	" "	
	2	2	3	" "		107		12	13	" "	
	3	4	5	" "		119		14	15	" "	
	4	6	7	" "		10 Ion Valve 109	0	1	on IX Unit 2		
	5	8	9	" "		110		2	3	" "	
	6	10	11	" "		111		4	5	" "	
	7	12	13	" "		112		6	7	" "	
	19	14	15	" "		113		8	9	" "	
7	Ion Valve 9	0	1	on IX Unit 1		114		10	11	" "	
	10	2	3	" "		115		12	13	near tank T7	
	11	4	5	" "		116		14	15	" " "	
	12	6	7	" "		11 Ion Valve 117	0	1	btwn. tanks T1 and T5		
	13	8	9	" "		118		2	3	" " " "	
	14	10	11	" "		120		4	air compressor to IX Unit 2		
	15	12	13	near tank T6		21		5	6	on IX Unit 1	
	16	14	15	" " "		22		7	8	" "	
8	Ion Valve 17	0	1	btwn. tanks T1 and T5		121		9	10	on IX Unit 2	
	18	2	3	" " " "		122		11	12	" "	
	120	4		air compressor for Unit1		Open		13 thru 15		spare	
CSOV 2		5		MP chlorine injection - MP system not in service							
CSOV 3		6		MP chlorine injection - MP system not in service							
vacant		7		spare							
CSOV 1		8		CW3 injection							
CSOV 6		9		CW4 injection							
CSOV 7		10		CW5 injection							
CSOV 8		11		CW6 injection							
CSOV 9		12		clarifier infl. injec. - Cl2 injection controlled by resid. chlorinator							
vacant		13 thru 15		spare							

PROGRAM to calculate 1.) Ion Exchange Operation Cycle; and 2.) Volumes and Sodium Concentrations of Reject Brine for a Given Desalting Scheme, IX Influent Process Water Chemical Concentrations and other information.

26-Mar 1986

IX SYSTEM EVENT FLOW RATES:		TH Working Resin Capacity: 0.86 (eq/liter of resin)			
	(gpm)	Volume of Resin in IX Unit:	162.2 (cu.ft.)	equals	4604 (liters)
Service	110	Volume of Voids in IX Unit:	188.7 (cu.ft.)	equals	1.16 (bv)
RecBrReg	200	Reg. Na Thruput to			
FrBrReg	150	Ser. TH Removed Ratio:	6.4 (eq: eq)		
SlowRinse	110	Total Na Thruput Required			
FastRinse	230	During Regen:	25340 (eq.)		

IX Process Water Concentrations			Influent Brine	OPERATION CYCLE:				
TH (mg/l as CaCO ₃)	Sodium (mg/l as Na)	Na Conc. (mg/l as Na)		Event	Duration (min.)	Volume (gal)	Volume (bv)	Output
influent:	2300	1980		Service	216	23777	19.55	CW5
effluent: (leakage)	100 (projected)	2990	Recycle future Fresh use	Recy. Brine Reg. 1	16	3125	2.57	IXSump
				Recy. Brine Reg. 2	23	4600	3.78	T2 or T3
				Fr. Brine Reg.	11	1710	1.41	T2 or T3
ERROR FLAGS:			Volume to IX Sump (gal.): 5730					
			Duration: Ser to Reg Ratio: 2.97					
			Na Thruput to Req'd. Ratio: 1.88					
			Na throughput for Regenerat'n.(eq.): 47750					

DESALTING PROCESS:							
Infl. Process Water		Reject Brine					
Flow	Na Conc.	Recovery	Na Reject	Volume		Na Conc.	Na per IX Cycle
gpm	mg/l Na	%	%	gal	bv	mg/l as N	eq.
Stage 1	92	future	50	96.0	9940	8.17	5860
Stage 2	46	use	50	95.4	4970	4.09	11450
Stage 3	24	"	67	94.0	1710	1.41	33300
Stage 4	0	"	0	0.0	1710	1.41	9370

Final Desalting Reject Brine Used for IX Regeneration:

Fresh IX Brine:

Volume:	1710 (gallons)
Na Conc.:	33300 (mg/l Na)

Instructions:

1. Load 123, BRVOL file.
2. Enter actual IX flows in blocks D7, D8, D9, D10 and D11. Flows are in gallons per minute.
3. Enter Total Hardness (TH) working capacity in block J5. Resin capacity in in eq. per liter of resin.
4. Enter volume of resin and voids (cu.ft.) in blocks J6 and J7 for IX Unit.
5. Enter ratio for regeneration sodium thruput to service TH removed (eq.:eq) in block J9.
6. Enter TH (mg/l as CaCO₃) and Sodium (mg/l as Na) conc. for IX influent process water in blocks C19 and D19.
7. Enter TH leakage (mg/l as CaCO₃) for IX process water effluent in block C20.
8. Enter flow (gpm) of influent process water for each desalting stage in blocks C29, C30, C31, and C32.
9. -future -Enter Na conc. (mg/l as Na) of infl. process water for each desalt. stage in blocks D29, D30, D31, and D32.
10. Enter recovery(%) of process water for each desalting stage in blocks E29, E30, E31 and E32
11. Enter sodium rejection (%) of process water for each desalting stage in blocks F29, F30, F31, and F32.
12. Print block1 for output above with instructions or block4 without instructions.
13. Print block2 (service control valve 1-110gpm) or block3 (control valve 2-230gpm) for complete IX operation schedule.
14. Dur. for events 2, 3, 4, 5, 11 and 12 of operations schedule are to individually entered into schedule and to be determined through actual operation.

ION EXCHANGE SYSTEM

APPENDIX H

LOS BANOS FACILITY

Volumes of Main Ion Exchange Columns

Resin: Date measured: July 7, 1986

Distance (in.) from bottom of top manifold to resin.		
	Unit	
Column	1	2
A	40.75	40.75
B	41	40.75

Volumes of resin:

	Unit 1		Unit 2	
Column	(cu.ft.)	(liters)	(cu.ft.)	(liters)
A	85.7	2433	85.7	2433
B	85.3	2421	85.7	2433
	171.0	4854	171.4	4866 Total (bv)
	1282 (gallons)		1286 (gallons)	
	154.2	4377	154.6	4388 Total above CL of
	1156 (gallons)		1159 (gallons)	bottom manifold
	162.6	4615	163.0	4627 Average of totals
	1219 (gallons)		1222 (gallons)	above

Time required in minutes to displace
Volume of Voids (CVV) for
various flows:

	Flow (gpm)			
	200	150	110	230
Unit 1	7.1	9.4	12.8	6.1
Unit 2	7.1	9.4	12.8	6.1

Time required to displace 1 bed volume
for various flows: (minutes)

	Flow (gpm)			
	200	150	110	230
Unit 1	6.4	8.5	11.7	5.6
Unit 2	6.4	8.6	11.7	5.6

Flows in bed volumes per minute (bv/min)

	Flow (gpm)			
	200	150	110	230
Unit 1	0.156	0.117	0.086	0.179
Unit 2	0.156	0.117	0.086	0.179

Volume of Voids (CVV) within column:

32 Percent voids in resin

UNIT

	1		2	
Column	(cu.ft.)	(gallons)	(cu.ft.)	(gallons)
A	94.1	706	94.1	706
B	94.4	708	94.1	706
Total Volume of Voids (CVV):	188.4	1413	188.2	1411
	5350 (liters)		5347 (liters)	

History of Resin Levels:

Date Measure	Unit 1		Unit 2	
	Col.A	Col.B	Col.A	Col.B
7/2/85	38	40.5	44	42.5
10/23/85	38.38	38.25	38.25	38.38
3/17/86	41	41	41	41
7/7/86	40.75	41	40.75	40.75

1. Enter 123, Volumes file
2. Enter date measured in block E3.
3. Enter distances in blocks D9, D10, E9 and E10. Distances are in inches from bottom of top manifold to resin.
4. Enter percent of voids in block D31
5. Enter flows in blocks K10, L10, M10 or N10. Flows entered are gallons per minute.
6. Enter new resin levels under History section, blocks below J31.

Duolite International

15 May 1984
TSC-8493

Mr. John Ho
Los Banos Desalting Facility
3400 E. Pacheco Blvd.
Los Banos, CA 93635

Dear John:

Please find enclosed the analysis results of the Duolite C-20 sample submitted to our laboratory for evaluation.

The resin is in excellent condition, display capacity, moisture retention and sphericity exceeding specifications for new material. The iron content is insignificant, indicating iron fouling is not a problem at this time. The sample we received contained a small amount of unidentified spongy white particulate matter. You indicated during our telephone conversation that this may be gypsum carry-over. In any case, it should be removed from the softeners by vigorous backwashing.

As we discussed during your visit, the major limitation in your system in obtaining longer runs is the high sodium-to-hardness ratio (2:1). Based on extrapolation of Figures 5 and 6 in Duolite Data Bulletin 24, you can expect a capacity of ~13 Kgr/cu.ft. (as opposed to the 32 Kgr/cu.ft. capacity quoted in the 4/15/83 letter from PRC to Kurt Kovac) using Duolite C-20 or any other 8% crosslinked strong-acid cation exchanger. This capacity rating with your operating conditions should give a 65-minute run length, as outlined in the following calculations:

$$\begin{aligned} 2300 \text{ ppm} &= 0.13 \text{ Kgr/gal} \\ 0.13 \text{ Kgr/gal} \times 115 \text{ gpm} &= 15 \text{ Kgr/min} \\ 75 \text{ ft}^3 \times 13 \text{ Kgr/ft}^3 &= 975 \text{ Kgr} \\ \underline{975 \text{ Kgr}} &= 65 \text{ min} \\ 15 \text{ Kgr/min} & \end{aligned}$$



Diamond Shamrock

Duolite International, Inc. A subsidiary of Diamond Shamrock Corporation
800 Chestnut St., Redwood City, California **H40016**
Telephone: 415-369-0071 Telex: 910-378-5412 Cable: DIASHAMRES

John Ho
Los Banos Desalting Facility
15 May 1984 APPENDIX H
TSC-8493
Page Two

LOS BANOS FACILITY

The other major problem you must address is the use of filtered hard water for dilution of brine. If this practice continues you will begin to experience unacceptable hardness leakage.

Please call if I can be of further assistance as we look forward to working with you in optimizing your water treatment system.

Regards,

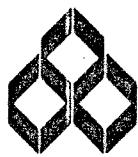
DUOLITE INTERNATIONAL, INC.

Kathy
Kathleen A. Haddock
Section Leader
Technical Service

KAH:vmr

enclosures

cc: Kurt Kovac - DWR
Steve Andrews - PRC

**Diamond Shamrock****Duolite** 
ION EXCHANGE RESINS

Company Los Banos Desalting Facility
Address 3400 E. Pacheco Blvd.
Los Banos, CA 93635
Attention John Ho

Application Softener
Reason for Work short runs
Date 25 April 1984 Ref. MA 1689:83
Reported By Kathleen A. Haddock

TESTS		RESULTS					
Sample No.	Cust.	used resin					
	DS	84272					
Resin	Duolite	C-20					
Total Capacity, Eq/l							
Salt-splitting Capacity, Eq/l	(Na ⁺)	2.08					
Moisture Retention Cap, %	(Na ⁺)	47					
Rinse, Bed Vols., to 40 μMho/cm							
Rinse, Bed Vols., to 10 μMho/cm							
Sphericity, %		98					
Color		dark amber					
Transparency		translucent					
Iron, mg/L resin		156					
Contamination		* notes					
Particle Size Distribution		16	40	16	40	16	40
U.S. Standard Sieve, Moist		20	50	20	50	20	50
Percent by Volume		30	Pn	30	Pn	30	Pn

*Sample contained small amount of unidentified spongy white particulate matter.

REPLY TO:
ONE DUFFEL CENTRE, SUITE 105
39899 VALENTINE DRIVE
NEWARK, CALIFORNIA 94580
(415) 859-0990



September 30, 1986

Mr. Kurt Kovac
California Department of Water Resources
Los Banos Demonstration Desalting Facility
3400 East Pacheco Boulevard
Los Banos, California 93635

Dear Mr. Kovac:

Attached please find the results of the laboratory work on the resins from your plant. Overall they are in pretty good condition, with just some very low levels of iron fouling. Beds 1 through 3 are showing some slight chemical deterioration as measured by an increasing moisture content. For a softener application, you shouldn't see any performance problems until the moisture content exceeds 55 percent.

Very truly yours,

ROHM AND HAAS COMPANY

E.C. Feeney, Jr.

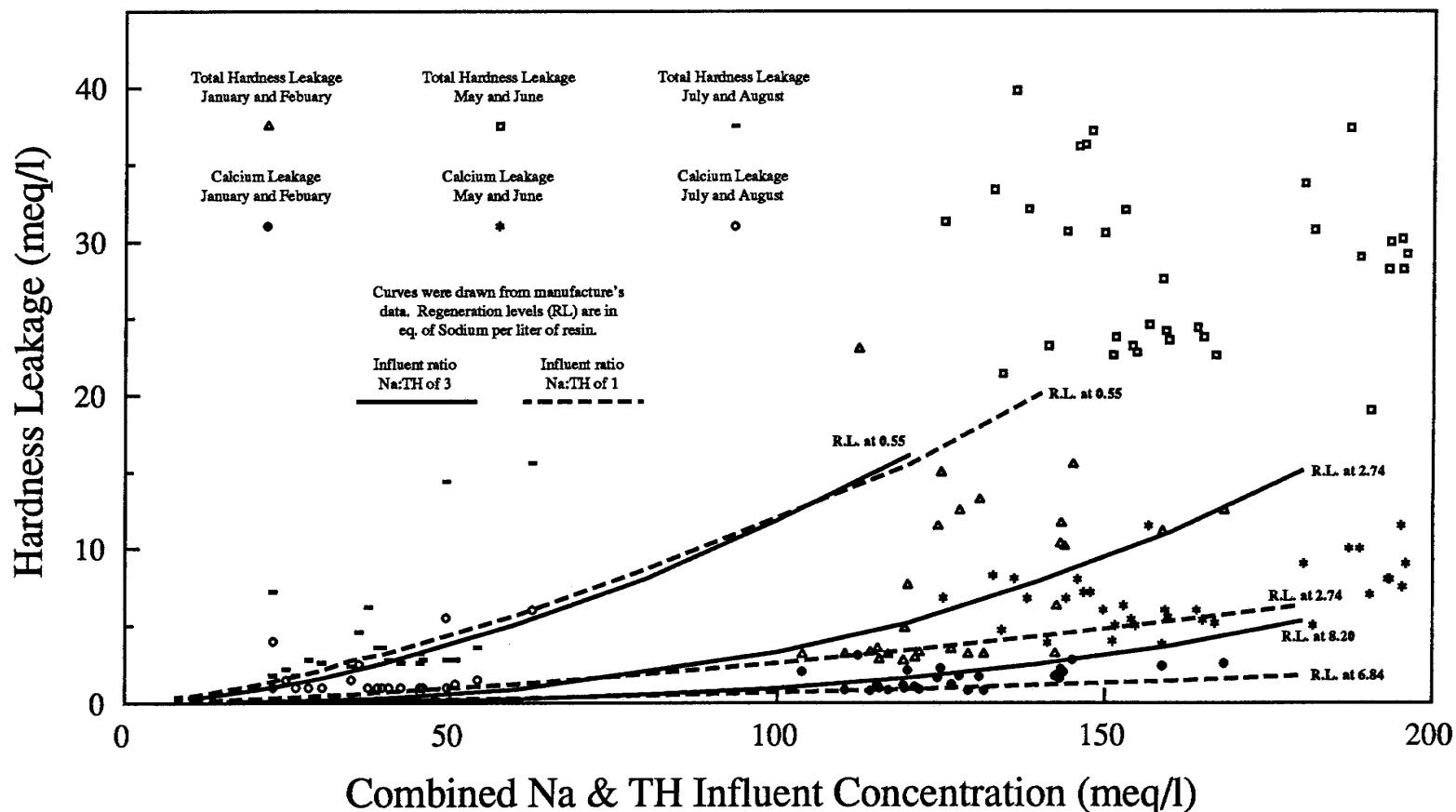
Eleanor C. Feeney

ECF/so
Encl.

ROHM AND HAAS FLUID PROCESS CHEMICALS SALES SERVICE REPORT

CUSTOMER	CA.DEP.T OF WATER RESOURCES LOS BANOS PLANT	PROJECT CV5490
START DATE	08/15/86	
COMPLETION DATE	08/15/86	
RESIN	DUOLITE C20	
SAMPLE ID	CATION #1	
PROPERTY	UNITS	VALUE TYPICAL VALUES
MOISTURE HOLDING CAPACITY	%	51.3 44-48
WHOLE BEADS	%	91 90 MIN.
IRON FOULING	VCS	2
CATION SALT SPLIT CAPACITY	MEQ/L	4.7 4.4 MIN.
RESIN	DUOLITE C20	
SAMPLE ID	CATION #2	
PROPERTY	UNITS	VALUE TYPICAL VALUES
MOISTURE HOLDING CAPACITY	%	49.0 44-48
WHOLE BEADS	%	90 90 MIN.
IRON FOULING	VCS	3
CATION SALT SPLIT CAPACITY	MEQ/L	4.47 4.4 MIN.
RESIN	DUOLITE C20	
SAMPLE ID	CATION #3	
PROPERTY	UNITS	VALUE TYPICAL VALUES
MOISTURE HOLDING CAPACITY	%	49.7 44-48
WHOLE BEADS	%	91 90 MIN.
IRON FOULING	VCS	2
CATION SALT SPLIT CAPACITY	MEQ/L	4.52 4.4 MIN.
RESIN	DUOLITE C20	
SAMPLE ID	CATION #4	
PROPERTY	UNITS	VALUE TYPICAL VALUES
MOISTURE HOLDING CAPACITY	%	45.3 44-48
WHOLE BEADS	%	90 90 MIN.
IRON FOULING	VCS	2
CATION SALT SPLIT CAPACITY	MEQ/L	4.67 4.4 MIN.

**Resulting Hardness Leakage for Combined
Influent Sodium and Hardness Concentrations
January through August, 1986**



REPORT FILES

APPENDIX H

LOS BANOS FACILITY

FILE NAME	FILE TYPE	FILE CONTENTS	DATE	YEAR
<u>REPORT TABLES</u>				
TABLE2	Lotus 123	Initial Main Unit Startup	March - June	1984
TABLE3	Lotus 123	Bench-Unit Softening Results (series 100)		
TABLE4	Lotus 123	Bench-Unit Regenerant Brine Composition (series 100)		
TABLE5	Lotus 123	Bench Unit Operation Parameters (series 200)		
TABLE6	Lotus 123	Hardness Leakage vs. Throughput		
TABLE8	Lotus 123	Ion Exchange Operation Schedule (manual operations)		
TABLE9	Lotus 123	Main Unit Operations		
TABLE10	Lotus 123	Main Unit Operations Schedule	December 3	1985
TABLE11	Lotus 123	Main Unit Operations	January-February	1986
TABLE12	Lotus 123	Main Unit Operations Schedule	April 28	1986
TABLE13	Lotus 123	Main Unit Operations	May - June	1986
TABLE14	Lotus 123	Main Unit Operations Schedule (default)		1986
TABLE15	Lotus 123	Main Unit Operations	July - August	1986
<u>REPORT FIGURES</u>				
FIGURE7	Graphwriter	IX Influent Water TH, CA and NA Conc.	June, July, August	1985
FIGURE8	Graphwriter	IX Influent Water TH, CA and NA Conc.	Jan, February	1986
FIGURE9	Graphwriter	IX Influent Water TH, CA and NA Conc.	May, June	1986
FIGURE10	Graphwriter	IX Influent Water TH, CA and NA Conc.	July, August	1986
FIGURE11	Graphwriter	Monthly S. Luis Drain TH, CA and Na Conc	March - June	1986
FIGURE12	Graphwriter	Resin Capacity and Calcium Leakage	June, July, August	1985
FIGURE13	Graphwriter	Volume of Softened Water Produced	June, July, August	1985
FIGURE14	Graphwriter	Resin Capacity and Calcium Leakage	January, February	1986
FIGURE15	Graphwriter	Resin Capacity and Calcium Leakage	May, June	1986
FIGURE18	Graphwriter	Resin Capacity and Calcium Leakage	July, August	1986
<u>APPENDIX A - BENCH UNIT SERIES 100 TEST DATA</u>				
OPER100	Lotus 123	Operation parameters for series 100 tests		
ANA100A	Lotus 123	Chemical analyses for series 100 tests (101 through 114)		
ANA100B	Lotus 123	Chemical analyses for series 100 tests (115 through 126)		
<u>APPENDIX B - BENCH UNIT SERIES 200 TEST DATA</u>				
OPER200	Lotus 123	Operation parameters for series 200 tests		
ANA200	Lotus 123	Chemical analyses for series 100 tests		
<u>APPENDIX C - BENCH UNIT SERIES 300 TEST DATA</u>				
BU300SUM	Lotus 123	Summary of results for series 300 tests		
BUCAP	Lotus 123	Operation parameters and chemical analyses for tests 301 through 313)		
RC1_HEAD	Graphwriter	Graph heading for test 1		
RC1_REG	Graphwriter	IX Regeneration Effluent test 1		
RC1_SER	Graphwriter	IX Service Effluent test 1		
RC2_HEAD	Graphwriter	Graph heading for test 2		
RC2_REG	Graphwriter	IX Regeneration Effluent test 2		
RC2_SER	Graphwriter	IX Service Effluent test 2		

REPORT FILES

APPENDIX H

LOS BANOS FACILITY

FILE NAME	FILE TYPE	FILE CONTENTS	DATE	YEAR
<u>APPENDIX C (CONTINUED) - BENCH UNIT SERIES 300 TEST DATA</u>				
RC3_HEAD	Graphwriter	Graph heading for test 3		
RC3_REG	Graphwriter	IX Regeneration Effluent test 3		
RC3_SER	Graphwriter	IX Service Effluent test 3		
RC4_HEAD	Graphwriter	Graph heading for test 4		
RC4_REG	Graphwriter	IX Regeneration Effluent test 4		
RC4_SER	Graphwriter	IX Service Effluent test 4		
RC5_HEAD	Graphwriter	Graph heading for test 5		
RC5_REG	Graphwriter	IX Regeneration Effluent test 5		
RC5_SER	Graphwriter	IX Service Effluent test 5		
RC6_HEAD	Graphwriter	Graph heading for test 6		
RC6_REG	Graphwriter	IX Regeneration Effluent test 6		
RC6_SER	Graphwriter	IX Service Effluent test 6		
RC7_HEAD	Graphwriter	Graph heading for test 7		
RC7_REG	Graphwriter	IX Regeneration Effluent test 7		
RC7_SER	Graphwriter	IX Service Effluent test 7		
RC8_HEAD	Graphwriter	Graph heading for test 8		
RC8_REG	Graphwriter	IX Regeneration Effluent test 8		
RC8_SER	Graphwriter	IX Service Effluent test 8		
RC9HEAD	Graphwriter	Graph heading for test 9		
RC9_REG	Graphwriter	IX Regeneration Effluent test 9		
RC9_SER	Graphwriter	IX Service Effluent test 9		
RC10_HEAD	Graphwriter	Graph heading for test 10		
RC10_REG	Graphwriter	IX Regeneration Effluent test 10		
RC10_SER	Graphwriter	IX Service Effluent test 10		
RC11_HEAD	Graphwriter	Graph heading for test 11		
RC11_REG	Graphwriter	IX Regeneration Effluent test 11		
RC11_SER	Graphwriter	IX Service Effluent test 11		
RC12_HEAD	Graphwriter	Graph heading for test 12		
RC12_REG	Graphwriter	IX Regeneration Effluent test 12		
RC12_SER	Graphwriter	IX Service Effluent test 12		
RC13_HEAD	Graphwriter	Graph heading for test 13		
RC13_REG	Graphwriter	IX Regeneration Effluent test 13		
RC13_SER	Graphwriter	IX Service Effluent test 13		

APPENDIX D - MAIN UNIT OPERATION DATA AND TEST PLAN, 1985

JJALG85	Lotus 123	Log	June, July, August	1985
JJARG85A	Lotus 123	Operation data	June, July, August	1985
JJASV85A	Lotus 123	Service data	June, July, August	1985
MJJSR85A	Lotus 123	Service and Regeneration data	June, July, August	1985

APPENDIX E - MAIN UNIT OPERATION DATA AND TEST PLAN, JANUARY AND FEBRUARY 1986

JFLOG86A	Lotus 123	Log	January, February	1986
DAIJF86	Lotus 123	Operation data	January, February	1986
CW2JF86A	Lotus 123	Ion exchange influent	January, February	1986
CW5JF86A	Lotus 123	Ion exchange effluent	January, February	1986
BTF86A	Lotus 123	Brine tanks	January, February	1986

REPORT FILES

APPENDIX H

LOS BANOS FACILITY

FILE NAME	FILE TYPE	FILE CONTENTS	DATE	YEAR
APPENDIX F - MAIN UNIT OPERATION DATA AND TEST PLAN, MAY AND JUNE 1986				
MJLOG86A	Lotus 123	Log	May, June	1986
DAIMJ86	Lotus 123	Raw Operation Data	May, June	1986
DAIMJ86A	Lotus 123	Operation Data	May, June	1986
CW2MJ86A	Lotus 123	Ion exchange influent	May, June	1986
CW5MJ86A	Lotus 123	Ion exchange effluent	May, June	1986
BTMJ86A	Lotus 123	Brine tanks	May, June	1986
FMJ86BR	Graphwriter	Influent Total Hardness and Sodium Concentration	Feb., May, June	1986

APPENDIX G - MAIN UNIT OPEREATION DATA AND LEAKAGE TEST, JULY AND AUGUST 1986

JALOG86A	Lotus 123	Log	July, August	1986
DAIJA86	Lotus 123	Raw Operation data	July, August	1986
DAIJA86A	Lotus 123	Operation data	July, August	1986
CW1JA86A	Lotus 123	Ion exchange influent	July, August	1986
CW2JA86A	Lotus 123	Ion exchange influent	July, August	1986
CW3A86A	Lotus 123	Ion exchange effluent	August	1986
CW5JA86A	Lotus 123	Ion exchange effluent	July, August	1986
CW6JA86A	Lotus 123	RO Unit 2 effluent	July, August	1986
CW8JA86A	Lotus 123	RO Unit 3 effluent	July, August	1986
BTJA86A	Lotus 123	Brine tanks	July, August	1986
LEAKTSTA	Lotus 123	Leakage Test	August 6	1986
RJSCUPG	Lotus 123	Operation Instructions	August	1986
PREP_A	Lotus 123	Instructions for Dry Run of IX System	July	1986
JAU86BR	Graphwriter	Influent Total Hardness and Sodium Concentration	July, August	1986
LKAU86	Graphwriter	Leakage vs. Process Water Throughput	August	1986

APPENDIX H - GENERAL AND COMPUTER INFORMATION ON IX OPERATIONS

RJSCUPH	Lotus 123	Operations Schedule	August	1986
PROGM1_A	Lotus 123	IX Operations Program - Analog Devices MacSym Computer		
ANLGDEVA	Lotus 123	Device Connection to Analog Computer	April	1986
BRVOL2A	Lotus 123	IX/BRINE concentration program	March	1986
VOLUMESA	Lotus 123	Resin & Unit volume data	July	1986
RESNRPTA	Lotus 123	Sales Service Report	August	1986
RPTFILES	Lotus 123	List of report and appendix files		
HLVINF	Lotus 123	Manufacture's data curves		
NACA4.DRW	Freelance	Resulting Hardness Leakage	January - August	1986

REPORT DATA FILES

APPENDIX H

LOS BANOS FACILITY

FILE NAME	FILE TYPE	FILE CONTENTS	DATE	YEAR
DIR	Lotus 123	Directory of Ion Exchange Data Files		
BENCH UNIT DATA				
OPER100	Lotus 123	Operation parameters for series 100 tests		
ANA100A	Lotus 123	Chemical analyses for series 100 tests (101 through 114)		
ANA100B	Lotus 123	Chemical analyses for series 100 tests (115 through 126)		
OPER200	Lotus 123	Operation parameters for series 200 tests		
ANA200	Lotus 123	Chemical analyses for series 200 tests		
HDLK200	Lotus 123	Hardness and Calcium Leakages for series 200 tests		
BU300SUM	Lotus 123	Summary of results for series 300 tests		
BUCAP_	Lotus 123	Operation parameters and chemical analyses for Series 300 tests		
MAIN UNIT DATA				
JJALG85	Lotus 123	Log of Operations	June, July, August	1985
JJARG85	Lotus 123	Operation data	June, July, August	1985
JJASV85	Lotus 123	Service data	June, July, August	1985
MJJSR85	Lotus 123	Service and Regeneration data	June, July, August	1985
JFLOG86	Lotus 123	Log of Operations	January, Februaty	1986
DAIJF86	Lotus 123	Operation data	January, Februaty	1986
CW2JF86	Lotus 123	Clearwell Chemical Analyses	January, Februaty	1986
CW5JF86	Lotus 123	Clearwell Chemical Analyses	January, Februaty	1986
BTF86	Lotus 123	Brine Tanks Chemical Analyses	January, Februaty	1986
MJLOG86	Lotus 123	Log of Operations	May, June	1986
DAIMJ86	Lotus 123	Operation Data	May, June	1986
CW2MJ86	Lotus 123	Clearwell Chemical Analyses	May, June	1986
CW5MJ86	Lotus 123	Clearwell Chemical Analyses	May, June	1986
BTMJ86	Lotus 123	Brine Tanks Chemical Analyses	May, June	1986
JALOG86	Lotus 123	Log of Operations	July, August	1986
DAIJA86	Lotus 123	Operation data	July, August	1986
CW1JA86	Lotus 123	Clearwell Chemical Analyses	July, August	1986
CW2JA86	Lotus 123	Clearwell Chemical Analyses	July, August	1986
CW3JA86	Lotus 123	Clearwell Chemical Analyses	August	1986
CW5JA86	Lotus 123	Clearwell Chemical Analyses	July, August	1986
CW6JA86	Lotus 123	RO Unit 2 effluent	July, August	1986
CW8JA86	Lotus 123	RO Unit 3 effluent	July, August	1986
BTJA86	Lotus 123	Brine Tanks Chemical Analyses	July, August	1986
LEAKTST	Lotus 123	Main Unit Leakage Test	August 6	1986
PROGM1	Lotus 123	IX Operations Program - Analog Devices MacSym Computer		
ANLGDEV	Lotus 123	Device Connection to Analog Computer	April	1986
BRVOL2	Lotus 123	IX/BRINE concentration program	March	1986
VOLUMES	Lotus 123	Resin & Unit volume data	July	1986
RESNRPT	Lotus 123	Sales Service Report	August	1986
RPTFILES	Lotus 123	List of report and appendix files		
HLVINF	Lotus 123	Manufacture's data curves		

GLOSSARY

Bed volume (BV): the volume of resin in an ion-exchange unit.

Breakthrough: rapid increase in the concentration of an absorbed ion in the service effluent water. Breakthrough indicates a nearly exhausted resin with respect to that ion.

Calcium hardness: the amount of calcium in a solution.

Column voids volume (CVV): the volume of liquid that an ion-exchange unit containing resin can hold. $CVV = CV - (BV \times VV)$ where VV is the percent of resin voids volume.

Column volume (CV): the volume of an ion-exchange unit.

Cycle: sequential steps in events that comprise the ion-exchange process.

Electrodialysis (ED): a desalting process driven by an electromagnetic force (direct-current voltage) applied across a series of alternating cation and anion selective membranes. The voltage causes ion diffusion through the membranes yielding dilute and concentrated streams.

Equivalents per liter (eq/L): (1) the concentration of an element or ion in a solution which is expressed as per liter of solution; (2) the amount of ionic equivalents passed through the resin bed during regeneration or the amount of ionic equivalents absorbed by the resin (resin capacity) during service. These amounts are expressed as equivalents per liter of resin.

Electrodialysis reversal (EDR): an advancement in the electrodialysis process in which the polarity of the applied direct current field is automatically reversed at set intervals. This reversal eliminates many of the operational problems associated with electrodialysis.

Equivalents: the mass of an element or ion present in grams divided by its equivalent mass.

Equivalent weight: the atomic or molecular weight of element or ion divided by its valence.

Hardness leakage or leakage: the amount of calcium, magnesium, and other divalent ions that remains in the effluent of the service event.

Hardness or total hardness: the amount of divalent cations, mainly calcium and magnesium, in a solution.

Loading rate 1 (LR1): hydraulic loading rate expressed in terms of gallons per minute per square foot of cross-sectional area or its metric equivalent.

Loading rate 2 (LR2): hydraulic loading rate expressed in terms of gallons per minute per cubic foot of resin or its metric equivalent.

Regeneration: the phase of the ion-exchange cycle where a solution with a high concentration of sodium is passed through the resin bed. During the passage, sodium ions displace the hardness ions in the resin that were absorbed during service.

Resin capacity: a quantitative measure of equivalents of ion or ions absorbed by a resin per unit volume of resin. Resin capacity is a function of resin properties, water composition, regenerant brine composition, and ion-exchange operating conditions.

Reverse osmosis (RO): a desalting process in which a semipermeable membrane is used to separate dissolved solids from water with an applied pressure greater than the osmotic pressure as the driving force.

Rotating-disk wiped-film evaporator (RED): a distillation process in which the feedwater is spread as a thin film on rotating disks by means of wipers. Separation of the feedwater into distillate and blowdown streams is accomplished by a combination of evaporation and centrifugal force.

Service (softening): that portion of the ion-exchange cycle that removes hardness ions from the process water.

Service factor: the ratio of the ion-exchange cycle's service duration to that of the entire ion-exchange cycle.